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Tillage and residue management effects on soil aggregation, organic carbon dynamics and yield attribute in rice–wheat cropping system under reclaimed sodic soil

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ABSTRACT

Conservation tillage and residue management are the options for enhancing soil organic carbon stabilization by improving soil aggregation in tropical soils. We studied the influence of different combinations of tillage and residue management on carbon stabilization in different sized soil aggregates and also on crop yield after 5 years of continuous rice–wheat cropping system on a sandy loam reclaimed sodic soil of north India. Compared to conventional tillage, water stable macroaggregates in conservation tillage (reduced and zero-tillage) in wheat coupled with direct seeded rice (DSR) was increased by 50.13% and water stable microaggregates of the later decreased by 10.1% in surface soil. Residue incorporation caused a significant increment of 15.65% in total water stable aggregates in surface soil (0–15 cm) and 7.53% in sub-surface soil (15–30 cm). In surface soil, the maximum (19.2%) and minimum (8.9%) proportion of total aggregated carbon was retained with >2 mm and 0.1–0.05 mm size fractions, respectively. DSR combined with zero tillage in wheat along with residue retention (T_6) had the highest capability to hold the organic carbon in surface (11.57 g kg^{-1} soil aggregates) with the highest stratification ratio of SOC (1.5). Moreover, it could show the highest carbon preservation capacity (CPC) of coarse macro and mesoaggregates. A considerable proportion of the total SOC was found to be captured by the macroaggregates (>2–0.25 mm) under both surface (67.1%) and sub-surface layers (66.7%) leaving rest amount in microaggregates and 'silt + clay' sized particles. From our study, it has been proved that DSR with zero tillage in wheat (with residue) treatment (T_6) has the highest potential to secure sustainable yield increment (8.3%) and good soil health by improving soil aggregation (53.8%) and SOC sequestration (33.6%) with respect to the conventional tillage with transplanted rice (T_1) after five years of continuous rice–wheat cropping in sandy loam reclaimed sodic soil of hot semi-arid Indian sub-continent.

1. Introduction

Soil aggregation is an imperative mechanism contributing to soil fertility by reducing soil erosion and mediating air permeability, water infiltration, and nutrient cycling (Spohn and Giani, 2011; Zhang et al., 2012). Soil aggregates are important agents of soil organic carbon (SOC) retention (Haile et al., 2008) and protection against decomposition (Six et al.,

Abbreviations: AR, aggregate ratio; AS, aggregate stability; CPC, carbon preservation capacity; CMacA, coarse macroaggregate; CMacAC, coarse macroaggregated carbon; CMicA, coarse microaggregate; CMicAC, coarse microaggregated carbon; CT, conventional tillage; DSR, direct seeded rice; EWY, equivalent wheat yield; FMicA, fine microaggregate; FMicAC, fine microaggregated carbon; GMD, geometric mean diameter; MWD, mean weight diameter; MesoA, mesoaggregate; MesoAC, mesoaggregated carbon; OC, oxidizable organic carbon; RT, reduced tillage; SOM, soil organic matter; TC, total soil carbon; TIC, total soil inorganic carbon; SOC, total soil organic carbon; TPR, transplanted rice; WSA, water stable aggregates; WSMacA, water stable macroaggregates; WSMicA, water stable microaggregates; ZT, zero tillage.

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